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The Role of Climate-Forest Interface in Climate Resilient Green Economy of Ethiopia

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Abstract
It is time for courageous collective effort to reduce the rate of climate change to the level that occurs naturally and to design mechanism to handle the effect of climate change. Though the problem of climate change is global its effect on the developing countries like Ethiopia are very significant, because of less capacity to reduce and reverse the problem. Ethiopia has always suffered from great climatic variability; that causes for various socio-economic and environmental problems. This review paper examines why and how climate and forest matters to the climate resilient green economy of Ethiopia. Different researchers explain that, Ethiopia has lost a cumulative level of over 13 % of its current agricultural output between 1991 and 2010. And if no adaptation measures are taken, climate change may reduce Ethiopia's GDP by up to 10% by 2045.The government of Ethiopia therefore recognizes the importance of designing development policies with a view to climate change. In Ethiopia building the green economy is considered as necessity as well as an opportunity. In relation to CRGE become the timely slogan of Ethiopia which aims to stabilise its net greenhouse gas emission while building resilience to against current climate risks and future climate change.There are controversies among the risk in a changing climate, demand for economic development, reduction of agricultural productivity, and natural resource. So, CRGE approach follows the principle of harmonizing the controversies. But the efforts so far have done on climate and forest development are facing some challenges by population growth, high dependency of national energy on fuel wood, lack of good governance, lack of capacity to deliver core development services, complex agro-ecological zones, changing growing seasons, lack of real public policy discussion on the climate and policy contradiction like investment and settlement policy. Solving these challenges is very important to achieve the CRGE strategy of Ethiopia.
Keywords: Climate, Climate Resilient, Development, Forest, Green Economy, and Interface

1. Introduction

The global climate change has occurred because the equilibrium of the world carbon cycle has been troubled. In the year from 1956 to 2005 the mean global atmospheric temperature is increasing from 0.10 to 0.16 and over the next 100 years the increment is estimated to raise from1.1 to 6.4^{0}C (UNDP, 2011).The recent data shows that global surface temperature in 2012 were increased by 0.56°C /1°F (Hansen, M et al, 2013). But precipitation decrease most likely in tropic and sub tropical region and increase in at high latitude (IPCC 2007).However the research conducted by different scholars' shows various result, most of the finding reveals the increment of temperature.

The world is troubled with the climate change issues. It is one of the greatest global challenges in the 21st century that have got the attention of many countries (IPCC, 2007UNEP, 2007). It is clear that industrial sectors account 70% total global GHG emissions and most climates based policies and discussion has been focused on reducing industrial emissions. But it is impossible to imagine about the reduction of GHG and climate change stabilization excluding the carbon absorption and accumulation role of forest and soil. For instance, from the year 2000–2010 the annual GHG emission from land use and land-use change activities accounted approximately 4.3 to 5.5GtCO2eq/y. The global forests carbon store are more than 650 billion tons and in African alone forests sinks over 100gigatones of carbon (Smith. P, M, 2014 and GFRA, 2015).

In Ethiopia the forest minimized from 65% to 2.2% and the 90% of the highlands forest has dropped to 5.6% (World Bank, 2001). According to Berry, (2003) forests cover of Ethiopia a century ago has been approximately 40% of the land, but now have reduced to only 3%.Other report from FAO, (2010) shows the forest cover of Ethiopia is 12.2 million ha (11%).This better data of forest may be because of the effort made on soil and water conservation.

The major causes for widespread deforestation in Ethiopia is cutting forest for agriculture, forest fuel, fodder and construction materials, (Bishew,2001).It is results to release almost 500 teragrams of carbon. According to WBISPP's (2005) in Ethiopia conversion of forest to agricultural land causes for 55 Mt CO_2 to the atmosphere in 2010. At 2% deforestation, about 700,000 ha of 'forests' will be removed every year and releasing nearly 110 million CO_2 to the atmosphere (FAO, 2005 and IPPC 2007).

If we do not prevent the process of carbon emission, global warming and climate change will treat to the existence of all life on earth. Burnett (2013) reported that Ethiopia has been identified as one of the most vulnerable countries to climate variability and change, commonly drought and floods. The major factors for

vulnerability of the country are the type of agriculture which is dependent of rain-fed, poor population (low adaptive capacity), low access to (education, new information, technology, modern health services) as well as its geographical location and topography. Thus, reducing the vulnerability through mitigating and adapting to climate change can maintain growth and reduce poverty (Emerta.A, 2013).

In 2011 Ethiopia has formulated the policy of CRGE, with threegoals, these are economic growth, net-zero emission, and building climate resilient green economy, which targeted to take the financial opportunities and co-benefits of low emissions development. Building green economy is important policy of the time, because it improves the economic growth, create employment opportunity, and offer extra socio-economic benefits**.** In a business term an increase in production will make a corresponding increase in emissions of the same proportion. To complement the difference, it is vital to make sure projects capacities to confront climate change and the same projects do not lead to excessive emissions of greenhouse gases.

This shows the need to prepare appropriate environmental mitigation and adaptation policy and financial mechanisms (FAO, 2011 and Temesgen.G,*et al*, 2014).The climate change adaptation strategies of Ethiopia in the forest and agriculture sector are related with protecting and re-establishing forests for their economic and ecosystem services and agricultural technology development and promotion, disaster risk reduction, community based adaptation, governance and policy (Bashir.A, 2009).The two sectors which are forest and agriculture are the major drivers of climate change with GHGe. If this scenario is not controlled with effective implementation of CRGE policy, the country socio-economic and environmental problems will continue, because there is a strong integration among climate change and forest degradation and socio-economic issues.(MoARD & WB, 2007and IPCC 2007).

In this perspective this paper aimed to review the role of climate and forest interface in the climate resilient green economy of Ethiopia.

2. Results and Discussion

2.1 Climate and Forest Interface

The world's climate system and forest ecosystems are highly associated and as a result changes in either one of these systems noticeably activate a response in the other. The known impacts of climate change on forest are changes in tree growth and productivity, changes in forest area and competition between species, and changes in damage caused by natural disturbances. Such as fire, drought, introduced species, insect, pathogen, hurricanes, wind storms, and ice. Because forests are mostly sensitive to climate change, due to the long life-span of trees which does not let for rapid adjustment to environmental change (Shankar.P, 2010). The one table and one figure below shows the effect of climate change on forest resource.

Table 1: Climate factor and its level of effect

Climate Factor	Cell Level	Organism Level	Species Level	Ecosystem Level
CO_2 Increase	Photosynthetic rate increase	Growth rate increase	Decrease seed mortality	Biomass production increase
	Stomata conductance reduction	Water use efficiency increase	Increased recruitment	Alterations in species competitiveness
		Seed production increase	Period for individuals to reach maturity Changes in individual density	Changes in species composition
Temperature Increase	Photosynthesis increase or decrease	Primary production positive or negative changes	Regeneration rate changes	Alterations in species competitiveness
	Photosynthetic period can increase	Seed production changes	Possible increase in tree mortality	Species composition changes
	Transpiration increase		Negative consequences for species sensitive to temperature change	Soil mineralization increase
Rainfall regime change	Growth rate decrease	Seed mortality rate increase	Increase of mature individuals' mortality rate	Alterations in species competitiveness Species composition change

Source: Robledo, C. and Forner, C. (2005)

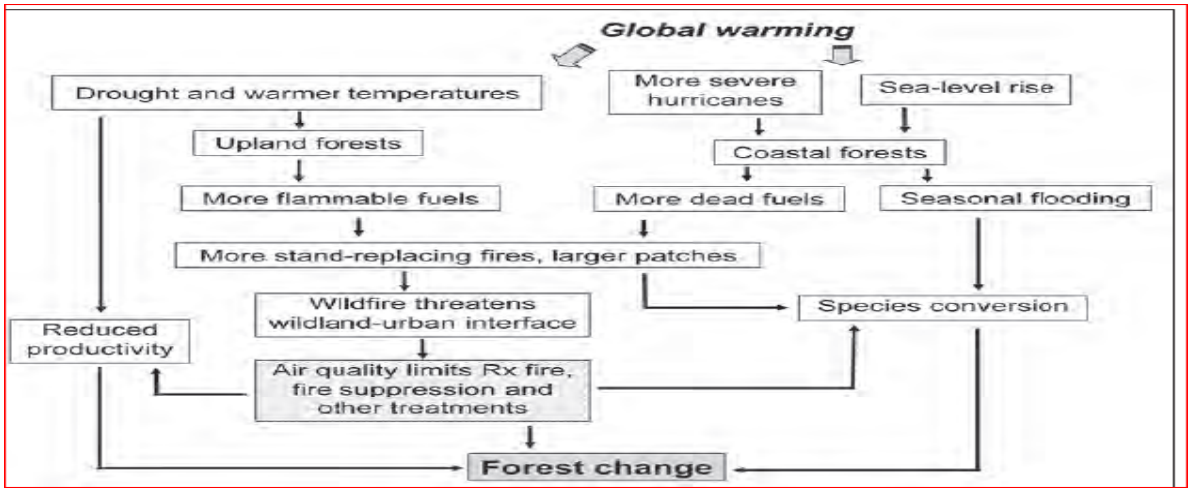

Figure 1: Global warming and its effect on forest **Source:** USDA, 2012

The climate factors such as CO2, temperature and rain fall and the change observed in the forest at the level of cell, organism, species and ecosystem (Table 1). The increase of global warming/climate change cause for warmer temperature; sever hurricane, sea level rise, flooding, wild fire, species conversion and change of forest (Figure 2). .

But increasing temperatures, longer dry seasons and increasing CO_2 concentrations in the atmosphere in the long term are expected to reduce the capacity of forests to store and sequester carbon, and possibly alter forests from carbon sinks to carbon sources (Nepstad*et al*, 2008). Climate change significantly determines, distribution, composition, structure, vegetation patterns and ecology either directly or indirectly (Fischlin*et al*., 2009 and Burton *et al*., 2010)

2.2 Climate change and alteration of plants boundary and composition

According to UNEP (2002), Lucier *et al*., (2009) and Fishlin *et al*., (2009) the rising temperatures or rain fall shortage forces many plants and living organisms to migrate to higher altitude/pole wards. Other researcher explain that not all plant species shift their area because some species will be able to adapt better to changing conditions than others, resulting in changes of composition of forest types, rather than geographic shifts of forest types (Breshears*et al*., 2008 and Lucier *et al*., 2009).But most research shows the migration of plants and other living organisms due to climate change.

Figure 2: Impact of climate change on mountain vegetation zones
Sources: UNEP/GRID-Arendal(2008); Benitson,(1994) and Watson,*et,al,*(1995).

The change of climate element like precipitation and temperatures causes for the shift of boundary for the vegetation to the higher altitude, disturbance of plant composition and species (Figure 2).

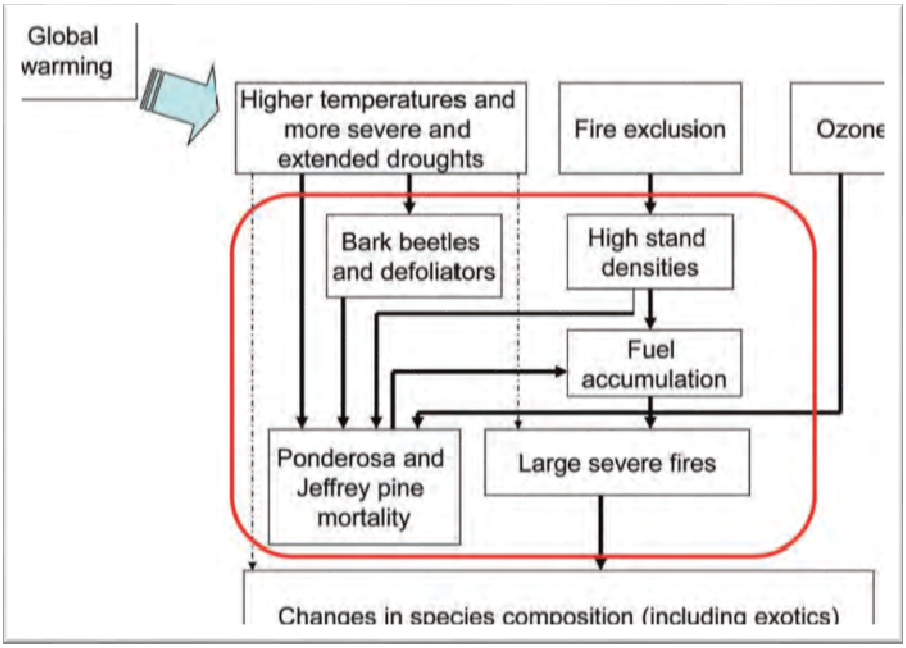

Figure 3: the effect of global warming on insect and forest fire
Source: McKenzie et al, 2007 cited in USDA, (2010)

The effects of global warming on insects and fire disturbance. Stand-replacing fires and drought-induced mortality both contribute to species changes and exotic invasions (Fig. 3). In Africa the natural attempt of plant to migrate to the higher altitude has no security for the plants, because the plant species found at the edge of the continent and at the tip of the Mountain will have no options for migration (Desanker, 2003).Therefore, Africa will logically face relatively higher risks from climatic change due to lack of migration paths for mountain species (Desanker,*et al,* 2001).In general climate change is held to increase biodiversity risks in Africa especially in Ethiopia (Fischlin *et al,* 2007).

2.3 Climate change and forest productivity

To some extent an increase in atmospheric CO_2 may speed up photosynthesis and provide CO_2 fertilization to the temperate forest areas (WRI, 2008). Doubling of CO_2 lead to increase in plant growth by 10-25 % (Nowak *et,al* 2004 and Norbay, *et al,*2005).It is estimated that forests in temperate regions have seen a 15 % productivity gain since the beginning of the 20th century (Medlyn, *et al,*2000).

In contrast the production increases in tropical forests will be temporal and will decrease once CO_2 saturation levels have been reached. Especially the growth of old forest will be reduced because of high mortality caused by low soil moisture and high food competition (Feeley, *et al*, 2007).The other productive impact of climate change were shifting time for flowering and bud break, altering hydrological process, such as precipitation, evaporation, run off, infiltration, soil moisture and other which are necessary for the growth of plant (Reinder.Brolsma, 2010).

2.4 Climate change- forest health and strength

For many forest types, forest health questions are of great fear with pest and disease outbreaks as major sources of natural disturbance. Increasing temperatures initiate the formation and expansion of insect/pests populations to the higher elevation or latitude to modify tree physiology and tree defense mechanisms, especially the host trees are more susceptible to pathogen infection (Herrington, *et al* 2001 and Lucier, *et al*., 2009).

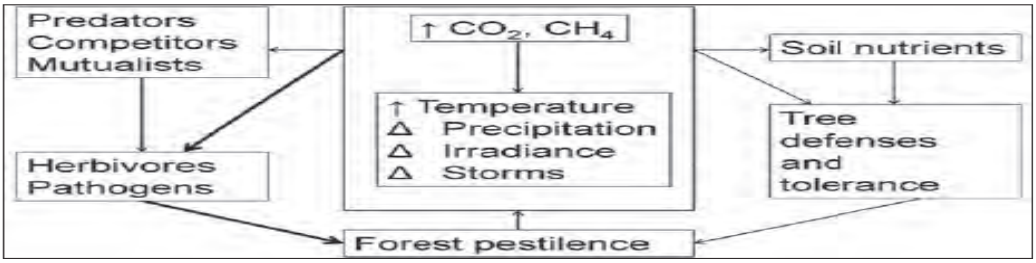

Fig 4: The effect of climate change on insects and pathogens **Source:** USDA,2012

The figure 4 depicts the general pathways by which atmospheric changes associated with increasing

greenhouse gases can influence forest disturbance from insects and pathogens. Climate influences the timing, frequency, and magnitude of disturbances. The environmental conditions required by some species such as those in alpine regions may disappear altogether and the result lead to the change of structure and function of ecosystem and this change is likely causes to a rapid increase the outbreak of insect and extinction of species (Dale et al. 2001).

2.5 The role of Forest in Climate Change

The interaction between forests and climate change is significant and often little understood, climate change is having and will continue to have higher impact on the forests through increased drought, heat waves, and wildfires. On the contrary forest ecosystems play decisive roles in climate regulation; it has greatest gifts in terms of their ability to trap polluting carbon from the atmosphere Fig. 5. Forests accounts for almost half the terrestrial carbon pool and act both as sources and sinks of greenhouse gases through which they exert significant influence on the earth's climate (Fischlin ,*et al,*2007).According to FAO (2006), Africa forest is estimated to contain over 100 Gt of carbon including in soils.

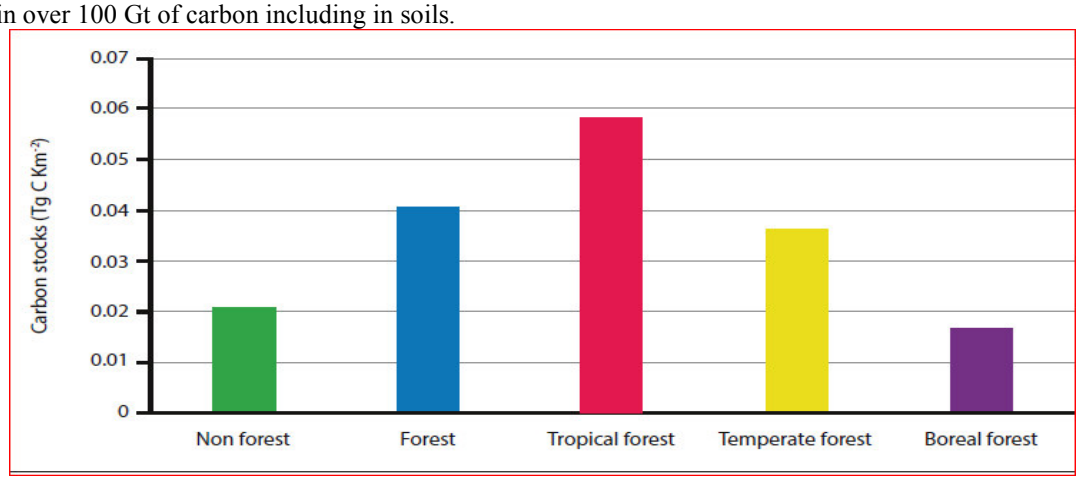

Figure 5. Carbon stock potential of different forest type. **Source:** Bonan(2008)

Tropical deforestation alone is responsible for approximately 20% of total human-caused carbon dioxide emissions each year (FAO, 2005, IPPC 2007 and Barker, *et al*, 2007). Protecting tropical forests alone contribute to store about 25% of the carbon in the terrestrial biosphere, because it cover about 15% of the world's land surface (CIFOR, 2009).The use of forest in climate change is multidimensional; besides the direct sinks and storage of carbon, forests have been playing important role in the climate change by water regulation and soil conservation which are a huge warehouse of carbon.

3. Conclusion and Recommendation

3.1 Conclusion

Though climate change become serious challenge the overall economic development and social wellbeing of the country is in a promising socio-economic track that the international organizations and development partners witnessed. But to adverse the negative impact of climate setting adaptation and mitigation plan such as CRGE is very important. As stated above the strong interfaces between forest, and climate are very challenging for Ethiopian effort to build CRGE and to realize the GTP, because the Ethiopian economy is highly dependent of rain fed agriculture which are highly vulnerable to the impact of climate change. So the development effort needs to harmonize the high demand for natural resource and the changing climate. In this regard the government is setting sound policies and strategies to build CRGE but it is not an end by itself, so the policy need to get acceptance by the people, there should be a suitable ground to implement the policy of natural resource conservations, avoid controversial policies, control population pressure to the natural resources and reduce other socio-economic problems.

3.2 Recommendations

Different researches conducted on climate change in the tropical region especially in the Sahel region shows continuous rise of temperature and reduction of rain fall, which has negative effect on the water resources, hydroelectric energy supply and the CRGE policy of Ethiopia, unless different adaptation, mitigation and correction measures are extensively used. These are,

- Financial need to building CRGE which is 150 billion USD for 20 years need to be available from both active involvement of the Ethiopian people and support from developed countries.
- Natural resource conservation activities and controlling population pressure to the natural resource

should be extensively practiced
- Alternative energy source should be available with cheap price.
- The impact of land tenure policy on the CRGE policy should be assessed.
- The government should work hardly on good governance and capacity building
- Environmental friendly investment and settlement policy should be formulated.

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